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(54) **Method and apparatus for vacuum treatment of an epidermal surface**

(57) When treating an epidermal surface (surface of the skin) (3) with subatmospheric pressure supplied from a source (not shown) through a flexible tube (6), an applicator (4) is used consisting of a first, porous layer (7) of e.g. felt and a second, airtight layer (8) of e.g. plastic sheet material, the edge portions (9) of which extend beyond the first layer (7) and form a seal against the epidermal surface (3).

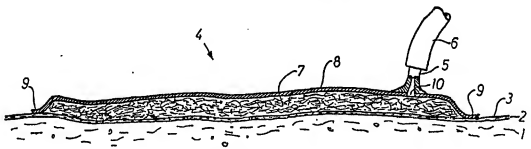

Fig.1

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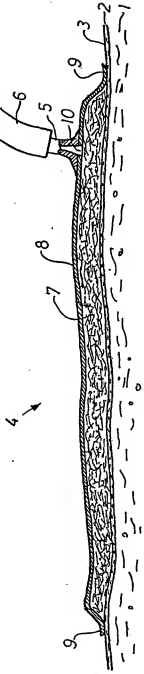

Fig.1

Fig.3

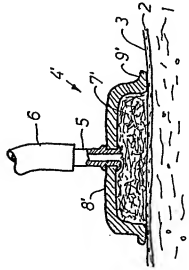

Fig.2

SPECIFICATION

Method and apparatus for vacuum treatment of an epidermal surface

The present invention relates to a method of applying subatmospheric pressure or partial vacuum to an epidermal surface.

Previously known methods of this kind usually involve placing the limb or other part of the body whose epidermal surface is to be treated with subatmospheric pressure, in a closed airtight chamber which is then evacuated, for example, by using a vacuum pump. To prevent the walls of the chamber from collapsing under the influence of atmospheric pressure, they must have considerable strength, especially in consideration of the subatmospheric pressure possibly being as low as 0.55 bar, corresponding to an external positive pressure on the chamber of almost half an atmosphere. Since the limb or part of the body in question is necessarily connected at one end to the body of the person in question, special measures must be taken to form an air-tight seal between that end of the vacuum chamber, through which the part of the body has been introduced, and that part itself. In cases where the subatmospheric pressure is to be applied to a large part of the body of the person in question, such as the part comprising the thorax and the abdominal cavity, the application of subatmospheric pressure to the outside of this part of the body may cause internal organs containing air or gases to be distended, and breathing may be disturbed.

Another disadvantage with the known methods is that the space within the vacuum chambers around the part of the body or limb may need to be of rather large volume, for which reason it may take a long time to evacuate them.

It is an object of the present invention to provide a method of the kind referred to free of the disadvantages mentioned above and being suitable for implementation by personnel without great technical ability with regard to operating apparatus.

According to the present invention there is provided a method of applying subatmospheric pressure to an epidermal surface, said method being of the kind comprising the formation of an airtight space outside said surface, said space being connected to a source of subatmospheric pressure activated to lower the pressure in said space, characterised in that said airtight space is formed by

(a) placing on and/or along said epidermal surface a first layer consisting of a porous and preferably flexible material of a kind comprising mutually communicating pores not losing the mutual communication when the material is subjected to compressive forces, and

(b) placing on the outside of said first layer and preferably also on the part of the epidermal surface closest thereto and not covered by said first layer, a second layer consisting of airtight and preferably flexible material.

Such a method is extremely easy to carry out, and provides partly the advantage that the force on the epidermal surface caused by the subatmospheric pressure is counterbalanced by the mechanical force produced by the same subatmospheric pressure acting on the second layer and hence on the epidermal surface. This force does, however, act on the epidermal surface solely on the relatively limited contact areas between the pores in the first layer, so that the epidermal surface facing the pores is fully influenced by the subatmospheric pressure. Experience has shown that the effect on the cutis and possibly underlying tissue is not inferior to the effect obtainable by using the previously known methods mentioned above.

The present invention also relates to an applicator for use in carrying out the method of the invention.

The invention will be further apparent from the following description with reference to the accompanying drawing in which:

Figure 1 is a sectional view showing a region of skin with an applicator according to a first embodiment placed thereon;

Figure 2 is a sectional view similar to Figure 1 through a skin region with an applicator according to a second embodiment; and

Figure 3 shows the use of a protective layer between the skin and the applicator on an enlerged scale.

The drawings shows diagrammatically a skin region consisting if subcutis 1 and epidermis 2, the latter having an external epidermal surface 3.

With the purpose of applying subatmospheric pressure to a part of the epidermal surface 3, there is on that surface placed a vacuum applicator 4, being connected to a source (not shown) of reduced pressure, which may be of a previously known type, through a tube-connecting stub 5 and a flexible tube 6.

In the embodiment shown in Figure 1, the vacuum applicator comprises a first layer 7, lying in contact with a part of the epidermal surface 3. The first layer 7 consists of porous material, the pores of which are interconnected and do not close upon application of a compressive force to the material. Such a material may for example be felt, which—as is well known—consists of mutually entangled fibres of wool or other natural or synthetic fibre. The vacuum applicator 4 further comprises a second layer 8, placed on top of (outside of) the first layer 7 and being so much larger than the latter in the extent of its area, that it is also in direct contact with the epidermal surface 3 with an edge portion 9. The second layer 8 is airtight and may, for

example, be constituted by a thin sheet of plastics or rubber. To make it possible to adapt the shape of the vacuum applicator 4 to the shape of the limb or body part in question, both the first layer 7 and the second layer 8 should be flexible, and this condition is fulfilled by using the materials mentioned.

In the second layer 8 there is formed e hole 10, and the tube-connecting stub 5 is secured to the second layer 8 in such a manner, such as by means of glue or cement, that the opening in the stub 5 communicates with the hole 10.

When the source (not shown) of subatmospheric pressure is connected to the flexible tube 6 the space between the epidermal surface 3 and the inside of the second layer 8 is evacuated through the stub 5 and the hole 10. If the first layer 7 were not present in this space, then the space would collapse immediately at the onset of the evacuation, and the second layer 8 would contact the epidermal surface in a fluid-tight manner, so that the subatmospheric pressure in the flexible tube 6 would be unable to reach the region of the epidermal surface covered by the vacuum applicator 4. The porous first layer 7 does, however, in a purely mechanical manner keep the second layer 8 spaced from the epidermal surface 3, for which reason the subatmospheric pressure between the fibres in the first layer 7 can propagate through the entire space between the epidermal surface 3 and the second layer 8, so that the part of the epidermal surface underlying the first layer 7 will in its entirety be subjected to subatmospheric pressure. At the same time, the epidermal surface 3 will be subjected to a mechanical force acting thereupon from the most adjacent fibres in the first layer 7, but since these fibers will only be in contact with a limited portion of the area of the epidermal surface 3, the major part of this surface will be subjected to the subatmospheric pressure.

Apart from the weight of the vacuum applicator 4, no net mechanical force is applied to the limb or body part comprising the epidermal surface 3, because the surface 3 is partly acted upon by an upwardly (as seen in Figure 1) directed force corresponding to the magnitude of the subatmospheric pressure multiplied by the area in question, while the epidermal surface 3 at the same time is acted upon by a downwardly directed force transmitted through the first layer 7, said downwardly directed force being caused by the effect of the very same subatmospheric pressure acting on the inside of the second layer 8, the area of which is substantially the same as the area of the epidermal surface 3 being acted upon. In spite of the apparently paradoxical situation involving the epidermal surface 3 simultaneously being acted upon by two equal and oppositely directed forces, the subatmospheric pressure in the first layer 7 will act upon the tissue below or behind the epidermal surface 3, since the subatmospheric pressure has access to the tissue through a rather large percentage of the surface, only the remaining part of the surface being acted upon by the mechanical force as directed downwards in Figure 1. Thus, practice has shown that by using a vacuum applicator constructed according to the principles illustrated in Figure 1 and explained in the foregoing, it is possible to obtain an effect on the cutis 1 2 and possibly the underlying tissue at least as effective as that obtainable using previously known apparatus for subjecting epidermal surfaces to subatmospheric pressures.

The first and second layers 7 and 8 respectively shown in Figure 1 may be extended in all directions and shaped in such a manner, that they for example form a bag-like or sleeve-like structure, that may be placed around a greater or smaller part of the body in question. In certain instances, however, it may be desirable to apply subatmospheric pressure to a very limited region of the epidermal surface, and in such cases it is possible to employ a vacuum applicator 4' as shown diagrammatically in Figure 2. Like the vacuum applicator 4 shown in Figure 1, the vacuum applicator 4' shown in Figure 2 also consists of e first layer 7' and a second layer 8'. Of these, the first layer 7' may—apart from the size—be identical to the first layer 7 shown in Figure 1, while the second layer 8' as shown in Figure 2 may be constituted by a vacuum cup, with which the tube-connecting stub 5 and with it the flexible tube 6 are connected in a known manner. The edge portion 9' of the vecuum cup 8' provides the requisite sealing effect against the epidermal surface 3.

In order to avoid the first layer 7 or 7' becoming dirty and to prevent the transmission of infectious matter from one person to another, it is possible as shown in Figure 3 to place a protective layer 11 between the epidermal surface 3 and the first layer 7 or 7'. The protective layer 11 should—of course—be made of a material capable of both transmitting the subatmospheric pressure and the mechanical force from the first layer 7 or 7', and to this end the protective layer 11 can suitably consist of a textile material, such as sheeting or the like, that may be disposable or laundered and/or sterilized.

The subatmospheric pressure being transmitted to the epidermal surface 3 by means of the vacuum applicator 4 or 4' may be of the order of magnitude 0.05 to 0.55 bar. The source of subatmospheric pressure (not shown) connected to the flexible tube 6 may be provided with means to adjust the subatmospheric pressure, possibly also means to vary this pressure in e preprogrammed manner, so that the subatmospheric pressure may be veried in a manner suitable for provid-

ing the desired effect on the epidermal region in question, possibly also the underlying tissue.

It will be appreciated that it is not intended to limit the invention to the above example only, many variations, such as might readily occur to one skilled in the art, being possible, without departing from the scope thereof as defined by the appended claims.

CLAIMS

1. a method of applying subatmospheric pressure to an epidermal surface, said method being of the kind comprising the formation of an airtight space outside said surface, said space being connected to a source of subatmospheric pressure activated to lower the pressure in said space, characterised in that said airtight space is formed by

(a) placing on and/or along said epidermal surface a first layer consisting of a porous and preferably flexible material of a kind comprising mutually communicating pores not losing the mutual communication when the material is subjected to compressive forces, and

(b) placing on the outside of said first layer and preferably also on the part of the epidermal surface closest thereto and not covered by said first layer, a second layer consisting of airtight and preferably flexible material.

2. A method according to claim 1, characterised by using as the first layer a layer of fibrous material.

3. A method according to claim 1 and claim 2 wherein said first layer is of felt.

4. A method according to claim 1, 2 or 3 characterised by using as the second layer a flexible sheet or foil.

5. A method according to claim 1 and claim 4 wherein said second layer is of plastics.

6. A method according to claim 1, 2 or 3 characterised by using as the second layer a vacuum cup, the internal space of which has substantially the same height as said first layer, and the peripheral edge of which is in contact with the epidermal surface around the first layer.

7. A method according to any one or any of the claims 1-6, characterised in that a protective layer of air-permeable material is placed on the epidermal surface prior to the first layer being placed thereon.

8. A method according to claim 7 wherein said protective layer is a textile material.

9. An applicator for carrying out the method according to any one or any of the claims 1-8, characterised by

(a) a first layer consisting of porous and preferably flexible material of the kind with mutually communicating pores not losing the mutual communication when the material is subjected to compressive forces, and

(b) a second layer adapted to be placed on the outside of the first layer and consisting of airtight and preferably flexible material, said second layer having a greater extent in area than said first layer and comprising means for connecting the space below or behind said second layer with a source of subatmospheric pressure.

10. An applicator according to claim 9, characterised in that said first layer consists of fibrous material.

11. An applicator according to claim 10 wherein said first layer is of felt.

12. An applicator according to claim 9, 10 or 11 characterised in that said second layer consists of flexible sheet material

13. An applicator according to claim 12 wherein said second layer is of plastics.

14. An applicator according to claim 9, 10 or 11 characterised in that said second layer consists of a vacuum cup, the internal space of which has substantially the same height as the first layer and the peripheral edge of which is adapted to be in contact with the epidermal surface around said first layer.

15. An applicator according to any one or any of the claims 9-14 characterised by a protective layer of air permeable material adapted to be placed between the epidermal surface and the first layer.

16. An applicator according to claim 15 wherein said protective layer is a textile material.

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